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(54) Abstract Title
Separate confinement heterostructure laser

(57) An SCH laser device fabricated in the (Al,Ga,In)P system has an active region (13) disposed within an optical guiding region (12, 14). The optical guiding region (12,14) is disposed between an n-doped cladding region (11) and a p-doped cladding region (15). Optical confinement layers (16, 17), are disposed at the interfaces between the optical guiding region (12, 14) and the cladding regions (11, 15). The optical confinement regions produce increased confinement of the optical field, and reduce the penetration of the optical field into the cladding regions. The optical confinement region (17) on the p-side of the device also serves as a potential barrier to the transport of electrons into the p-doped cladding region (15). The cladding regions (11,15) have a low Al mole fraction, so that they have a direct bandgap. This prevents carrier loss by trapping in the DX level in the cladding regions. In an alternative embodiment, the cladding regions have a graded composition, with their composition at the interface with the optical confinement layers (16, 17) being such that the DX level in the cladding regions is degenerate with the X-conduction band in the optical confinement layers (16, 17). The energy of the DX level in the cladding region is greater than the Fermi level in the cladding region, and the energy of the DX level increases away from the optical guide region.

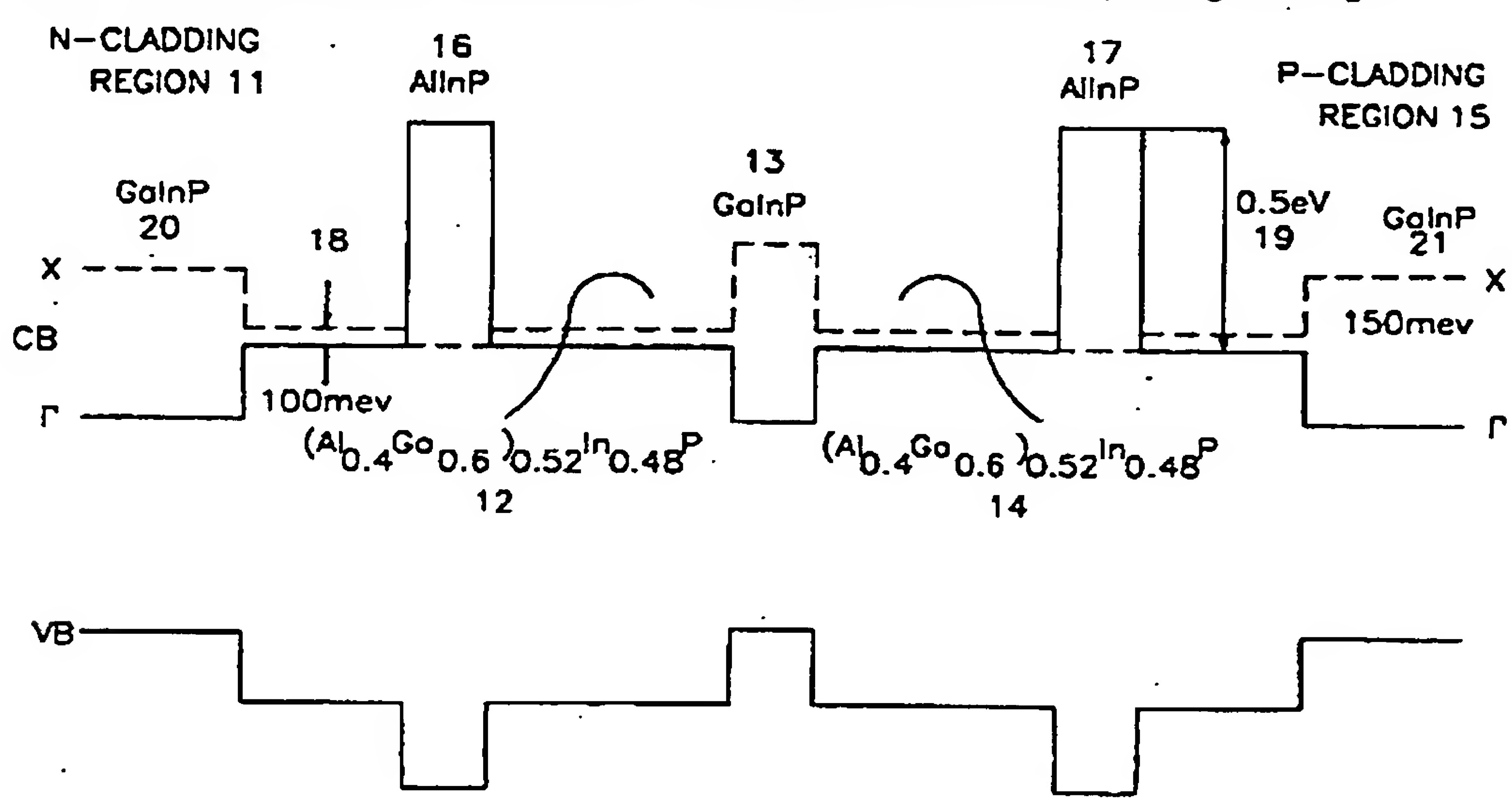

FIG.5

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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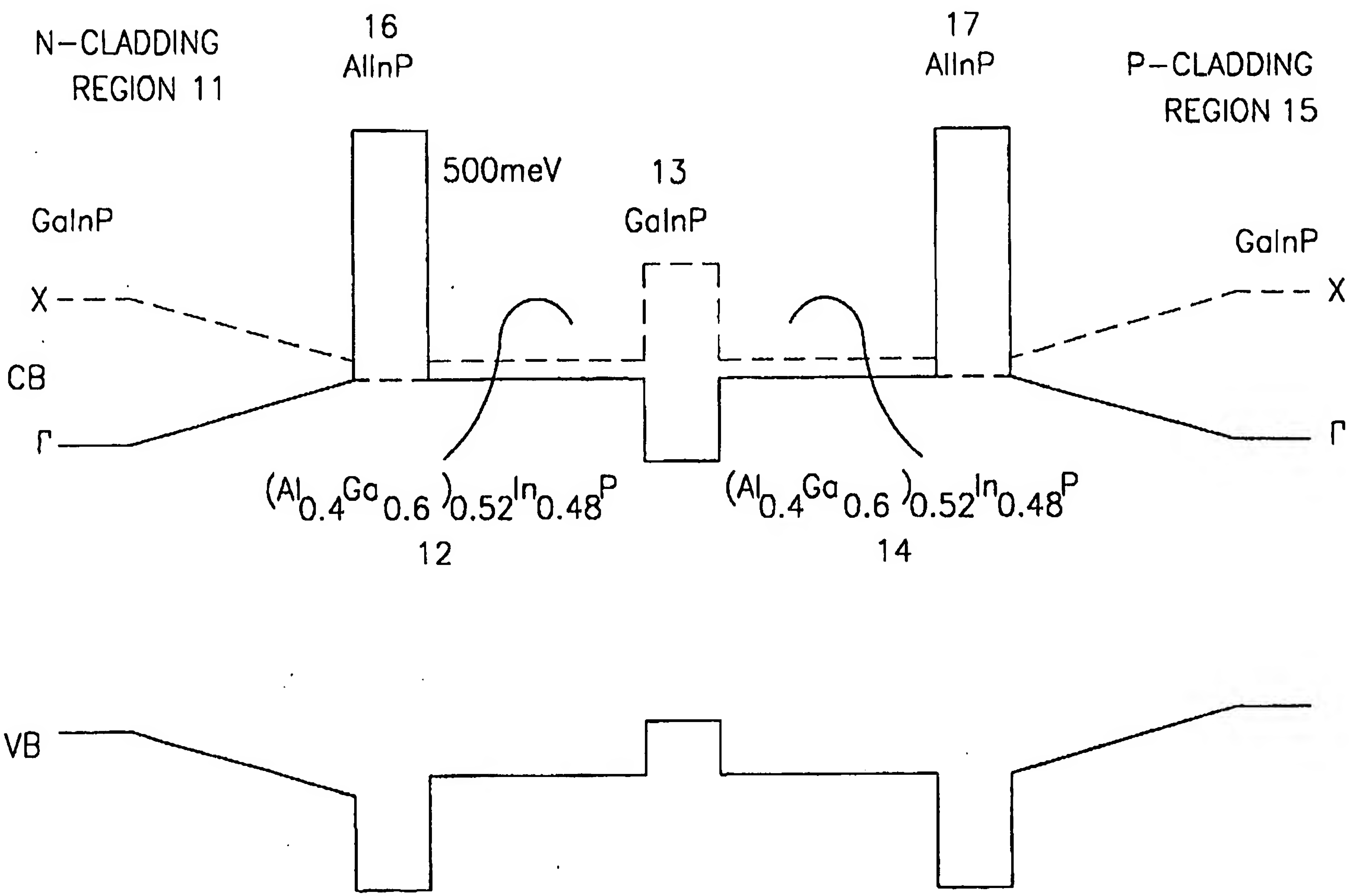
N-CLADDING
REGION 11
16
AlInP
500meV
13
GaInP
17
AlInP
P-CLADDING
REGION 15
GaInP
X
CB
Γ
$(Al_{0.4}Ga_{0.6})_{0.52}In_{0.48}P$
12
$(Al_{0.4}Ga_{0.6})_{0.52}In_{0.48}P$
14
GaInP
X
Γ
VB

FIG.4

The band structure of a SCH laser device according to a first embodiment of the present invention is shown schematically in Figure 4. This laser device consists of a $Ga_{0.52}In_{0.48}P$ active region 13 disposed within an optical guiding region 12, 14. The optical guiding region 12, 14 is formed of $(Al_{0.4}Ga_{0.6})_{0.52}In_{0.48}P$. The optical guiding region 12, 14 is disposed between an n-doped cladding region 11 and a p-doped cladding region 15.

The laser device of this embodiment is provided with two optical confinement layers 16, 17. In this embodiment these are formed of $Al_{0.52}In_{0.48}P$; one optical confinement layer is disposed at the interface between the n-doped cladding region and the optical guiding region, and the other is disposed at the interface between the p-doped cladding region 15 and the optical guiding region.

In this embodiment, the cladding regions 11, 15 each have a graded structure. At its interface with the optical confinement layer 16, the n-doped cladding region 11 consists of $(Al_{0.4}Ga_{0.6})_{0.52}In_{0.48}P$. The aluminium content of the n-doped cladding region decreases away from the interface with the optical confinement layer 16, eventually becoming zero to give a composition for the cladding region of $Ga_{0.52}In_{0.48}P$. The composition of the p-doped cladding region 15 has a similar variation, with the aluminium mole fraction being $y = 0.4$ at the interface with the optical confinement layer 17 and decreasing to zero away from the interface with the confinement region 17.

Providing the optical confinement layers 16, 17 has a number of advantages. Firstly, the refractive index of AlInP is approximately 5.7% lower than the refractive index of the $(Al_{0.4}Ga_{0.6})_{0.52}In_{0.48}P$ optical guiding layer 12, 14. In contrast, in the conventional laser shown in Figure 2, the refractive index of the $(Al_{0.7}Ga_{0.3})_{0.52}In_{0.48}P$ cladding regions 1, 5 is only around 2% lower than the refractive index of the $(Al_{0.5}Ga_{0.5})_{0.52}In_{0.48}P$ optical guiding region 2, 4. The much larger refractive index difference in the laser of Figure 4 means that there will be greatly improved confinement of the optical field, so that penetration of the optical field into the cladding regions 11, 15 will be greatly reduced. This will reduce absorption that occurs in the